PROCEEDINGS

48th Annual Meeting

WESTERN AGRICULTURAL ECONOMICS ASSOCIATION

Reno, Nevada

July 20, 21, 22, 1975

William D. Gorman, Editor

AN EMPIRICAL ANALYSIS OF THE IMPACTS OF ENERGY PRICE CHANGES ON FOOD COSTS

Norman K. Whittlesey and Chinkook Lee

Washington State University

This paper relates the findings of a recent study which measured energy use in the food system for some major agricultural products in Washington. More specifically, the study measured the total energy inputs into the production, processing, transporting, marketing, and home uses (preservation and preparation) of wheat, apples, potatoes, sugar beets, green peas, and dairy products. The data collected provide the basis for estimating the impacts of higher energy costs on Washington agriculture and consumers.

Energy Use in the Food System

Table 1 shows information related to energy use and costs in producing and consuming frozen peas. The data shown in this table are an example of similar data collected for other final food products.[1]

[1] Similar information for other products can be found in: Whittlesey, N.K. and Chinkook Lee, *Impacts of Energy Price Changes on Food Costs,* Washington Agricultural Experiment Station Bulletin in progress, 1975.

Total energy inputs required to produce, process, and consume one ton of peas as frozen peas[2] amounted to 16.4 million BTU's. More than one-third of the total energy is used for marketing frozen peas as these products require continuous refrigeration. This requirement for refrigeration also appears in transportation and the home where 7.3% of the total energy is used for refrigeration. Energy used for home cooking accounted for 20.5% while production and processing accounted for 12.6% and 13.2%, respectively.

Total energy costs for all activities were $52.84. One-third of the total cost is home cooking though cooking used only 20.5% of total energy. Household used electricity is the highest cost form of energy compared on a BTU basis. Petroleum products and natural gas, accounting for most of the energy used in production, processing, and

[2] The data presented here are in terms of one-ton of farm weight product. As commodities are processed into alternative forms, however, the final product weight may be quite different from the original. One ton of green peas, for example, will produce 1.37 tons of canned peas or .92 ton of frozen peas. Products which are dehydrated will lose up to 90% of fresh weight.

Table 1. Energy and cost data for one ton of green peas processed as frozen peas[a]

Item	Unit	Production	Processing	Transport	Wholesale and Retail Trade	Home Storage	Home Preparation	Total
Electricity	KWH		106.80		1,656.00	355.20	855.00	2,973.00
Gasoline	Gal	5.85	3.81					9.66
Diesel	Gal	5.64	.72	11.70[b]	2.70			20.76
Natural gas	Therm	2.71[c]	12.14				4.36	19.21
L-P gas	Gal		.23					.23
Fuel oil	Gal	2.51[c]						2.51
BTU	1,000	2,073.20	2,158.20	1,585.30	6,016.40	1,212.30	3,354.10	16,399.50
BTU/total BTU	%	12.60	13.20	9.70	36.70	7.30	20.50	100.00
Total energy cost	$	5.66	4.57	3.39	14.08	7.10	17.84	52.64
Total cost	$	95.61	140.00[d]	48.07	205.50	15.70	35.89	540.77
Energy $/total $	%	5.90	3.30	7.00	6.90	45.20	49.70	9.70

[a] One ton of farm weight green peas produces .92 ton of frozen peas or 2,944 ten ounce packages.

[b] Does not include local distribution which is accounted for in the trade sector.

[c] Used for fertilizer production.

[d] Does not include raw green pea costs.

transportation activities, are much cheaper forms of energy. It is also worth noting that about one-half the consumer's cost of storage and cooking are composed of energy inputs while the ratios of energy costs to total costs are less than 10% for production, processing, transportation, and trade.

To establish a basis for estimating energy impacts on food costs, the current market prices of final food products and the energy costs for each food related activity are summarized in Table 2. This table shows present energy costs calculated for a typical marketing unit of each commodity. The current costs of disembodied energy in a 17-ounce can of peas, for example, is shown to be $.0148. The market cost of this can of peas is $.46. Thus, we begin to see the potential effect on food costs that may be affected by changing energy costs. The distribution of these costs among industries such as processing or transportation also may be estimated. For example, energy costs in the transportation industry could be doubled with the effect of increasing the cost of a can of peas by about $.002, if all other costs were held constant. Similarly, doubling only food processing energy costs would increase the cost of a can of peas by $.0034.

Before going further it is necessary to indicate one important factor. The total energy costs shown in Table 2 include the energy used in home storage and preparation of food. For some commodities these activities account for as much as 73% of total energy costs. Though the cost of this household energy is a real part of consumer's food cost, its value is not reflected in the market prices of food. The consumer may not be fully cognizant of the amount and cost of this energy but the policy maker and researcher should recognize such costs when advocating or considering energy price changes.

Changing Energy Costs

To assess the food cost impacts, four alternative energy pricing schemes were selected. These pricing schemes, labeled Policies A-D, are:

Policy A: Petroleum prices are doubled while holding other energy prices constant.

Policy B: Electricity prices are doubled while holding other energy prices constant.

Policy C: Natural gas prices are doubled while holding other energy prices constant.

Policy D: All energy prices are increased 100%.

Table 3 shows the current total energy cost for each commodity and the energy cost under the alternative pricing policies. The current retail value of each food item is shown to provide a comparison for the magnitude of energy costs. For example, a 17 oz. can of peas has a retail value of $.46 while 10 lbs. of potatoes sell for $1.09. These retail food values were determined in January 1975 and are, therefore, subject to change over time.

Similarly the current cost of energy was established in the period December 1974 - January 1975. The energy costs are also changing but probably more slowly or with less variation than the prices of food. The third data column in Table 3 shows the percentage of the consumer's food cost currently contributed by energy inputs. These values range from as low as 1.7% for cheese to more than 10% for fresh potatoes. That is, more than 10% of a consumer's cost for fresh potatoes is expended for energy inputs. The data in Table 2 indicate that most of this energy is used in the home for cooking the potatoes. In general, foods requiring large energy inputs for processing, storage, or cooking will be more vulnerable to changing energy costs than those foods that can avoid such activities. It will

Table 2. Total energy cost per unit of final product by activity at present energy prices

Item	Unit of Final Product	Energy Cost per Unit of Final Product						
		Production	Processing	Transport	Wholesale and Retail Trade	Home Preservation	Home Preparation	Total
		dollars						
Canned peas	17 oz.	.0021	.0034	.0019	.0010		.0064	.0148
Frozen peas	10 oz.	.0019	.0015	.0011	.0047	.0024	.0061	.0178
Fresh potatoes	10 lbs.	.0091		.0211	.0009		.0850	.1162
Dehydrated potatoes	1 lb.	.0064	.0358	.0031	.0013		.0172	.0639
Sugar	5 lbs.	.0191	.0671	.0107	.0048			.1018
Wheat flour	10 lbs.	.0251	.0219	.0092	.0010		.1230	.1801
Fresh apples	2.5 lbs.	.0080		.0109	.0009	.0072		.0271
Apple juice	46 oz.	.0133	.0025	.0064	.0010	.0083		.0315
Fluid milk	1 gal.	.0159	.0081	.0044	.0088	.0227		.0600
Cheese	1 lb.	.0149	.0015	.0020	.0084	.0029		.0296
Butter	1 lb.	.0103	.0067	.0016	.0081	.0028		.0296
Dehydrated milk	1 lb.	.0110	.0138	.0012	.0009			.0269

Table 3. Total energy costs for each commodity and consumer food cost increases under policies A–D

Item	Unit of Final Product	Current Market Price	Current Energy Cost	Energy Cost Divided by Market Price	Energy Cost Under Policy (percent food cost increase) A	B	C	D
Canned peas	17 oz.	.46	.0148	3.22	.0200 (1.13)	.0221 (2.21)	.0172 (0.52)	.0296 (3.22)
Frozen peas	10 oz.	.33	.0178	5.39	.0218 (1.21)	.0309 (3.97)	.0188 (0.30)	.0356 (5.39)
Fresh potatoes	10 lbs.	1.09	.1162	10.66	.1428 (2.44)	.2001 (7.70)	.1215 (0.49)	.2324 (10.66)
Dehydrated potatoes	1 lb.	1.03	.0639	6.20	.0763 (1.20)	.0867 (2.21)	.0913 (2.66)	.1278 (6.20)
Sugar	5 lbs.	2.72	.1018	3.74	.1291 (1.00)	.1102 (0.31)	.1679 (2.43)	.2036 (3.74)
Wheat flour	10 lbs.	2.09	.1801	8.62	.2094 (1.40)	.3060 (6.02)	.2051 (1.20)	.3602 (8.62)
Fresh apples	2.5 lbs.	.75	.0271	3.61	.0441 (2.27)	.0367 (1.28)	.0276 (0.07)	.0542 (3.61)
Apple juice	46 oz.	.63	.0315	5.00	.0499 (2.92)	.0434 (1.89)	.0329 (0.22)	.0630 (5.00)
Fluid milk	1 gal.	1.60	.0600	3.75	.0772 (1.08)	.0987 (2.42)	.0637 (0.23)	.1198 (3.74)
Cheese	1 lb.	1.75	.0296	1.69	.0439 (0.82)	.0445 (0.85)	.0300 (0.02)	.0590 (1.69)
Butter	1 lb.	.81	.0296	3.65	.0412 (1.43)	.0439 (1.77)	.0331 (0.43)	.0594 (3.65)
Dehydrated milk	1 lb.	1.04	.0269	2.59	.0393 (1.19)	.0317 (0.46)	.0368 (0.95)	.0538 (2.59)

be noted that frozen or dehydrated potatoes have a lower percentage of total cost contributed by energy inputs. But each of these foods will contain about 50% more energy per pound of potatoes consumed than if the potatoes are not processed prior to reaching the consumer. The higher market value of these foods reduces the percentage of total cost contributed by energy, however.

The last four columns of Table 3 show the cost of energy per food item under the alternative energy pricing policies. The current cost of energy in a can of peas is $.0148. To double the price of all petroleum products used throughout the food chain would increase this cost to $.0200 (Policy A). Doubling electricity and natural gas prices would raise the energy cost per can of peas to $.0221 and $.0172, respectively (Policies B and C).

The effect of changing the cost of a particular form of energy will not be the same for all commodities. Those foods dependent upon large inputs of electricity for storage or cooking will be more vulnerable to changing electricity prices. Foods such as fresh potatoes requiring relatively larger amounts of petroleum products for production or transportation to market will be affected most by changing petroleum prices. Finally, highly processed foods are likely to be affected most by changing natural gas prices.

Table 3 shows the percentage change in consumer food costs that would be imposed by each of the energy pricing policies.

Policy A

Policy A, which doubles petroleum prices, increases consumer food costs about 1% to 3%. Doubling petroleum prices would increase the consumer's cost of both frozen and canned peas by slightly more than 1%. Potato food costs would increase from 1.2% if dehydrated to 2.4% if fresh. The consumer cost of sugar would increase only 1%. Dairy product costs would increase from 1% to 1.4%. Petroleum costs changes will most seriously affect the transportation and production sectors. Because of the long distance to market, apples, potatoes, and wheat are most seriously affected by changes in transportation costs.

Policy B

Policy B considers a 100% rise in electricity prices while holding other energy prices constant. Table 3

shows the effects of this policy on consumer food costs, though varied, to be slightly greater than when petroleum prices were doubled. Those commodities requiring refrigeration in processing, trade, or the home and/or substantial cooking had the largest cost increases. Frozen peas and fluid milk require refrigeration and the peas need to be cooked. Fresh potatoes and flour requiring large amounts of cooking energy, had larger percentage cost increases. A large share of the electricity used for commodities requiring refrigeration and cooking is consumed in the home. We estimate the share of electricity costs expended for food in the household to be 84% of the total electricity costs in the food system.

Policy C

Under Policy C natural gas prices would be increased 100%. Such a policy has effectively been implemented in Washington over the past 18 months. Table 3 shows this policy will increase food costs by less than 1% for most commodities. Dehydrated potatoes and sugar using natural gas in processing show final cost increases of about 2.5%.

Nitrogen fertilizer is largely produced using natural gas. However, even at a price of $1.00 per thousand cubic feet, several times the price of natural gas used for fertilizer production prior to the fall of 1973, natural gas contributes only about $40 to the cost per ton of anhydrous ammonia. Thus, a 100% increase in natural gas prices from today's level could add about 15% to the farm cost of nitrogen fertilizer which in turn could add about 3% to the farmer's cost of producing wheat. The effect would be even smaller for other crops.

Policy D

Policy D increases the cost of all energy by 100%. Such action could effect a 10% increase in the consumer's cost of fresh potatoes. Other commodities would be affected to a lesser degree. Wheat flour could increase by 8.6% by the time it is used for baking bread. Dairy product costs would generally increase by less than 4%.

Conclusions

It is apparent from these data that modest increases in energy costs should not result in significant food cost increases. The resulting change in food costs from a 100% change in petroleum prices averaged 2%; a 100% change in electricity prices caused food costs to rise about 2.3%; a 100% increase in natural gas prices caused food costs to increase about .7%; and a 100% increase in all energy prices would increase food costs about 5%. However, the impacts of an energy cost increase will not fall evenly on all sectors or commodities.

Governmental action causing, say, 25% - 50% increases in petroleum prices is not likely to result in substantial food cost increases, even though it will significantly affect the transportation and production sectors. That is not to say that food prices would not rise by more than 1% if petroleum prices were increased by 50%. But, such energy price increases should not directly result in larger food cost increases.

The household consumer currently pays the highest price per unit of electricity and also uses the larger share of electricity for refrigeration and cooking. Thus, the consumer will be affected most by increases in the price of electricity. Because electricity use is also concentrated in those commodities requiring refrigeration such commodities would be expected to receive the largest impacts of rising electricity prices.

Natural gas price changes fall most heavily on the food processing sector and those commodities requiring large amounts of heating during the processing. Sugar and dehydrated potatoes are examples of such commodities.